Dirt and Steel: 
The Case for Collaboration between Geotechnical and Structural Engineers

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Heroic Engineering?
The Big Idea

There is project value when geotechnical and structural engineers collaborate.
The Plan

Scope and Planning

Design

Construction
The Project Team

Owner
Engineer
Contractor

Geotechnical AND Structural?
Scope and Planning

Before a battle, planning is everything. Once the fighting has begun, it's worthless

—— Dwight D. Eisenhower ——
The Project Kickoff

- Project Description
  - Site Plan
  - Schedule
  - Milestones
  - Deadlines
  - Safety

Detailed Sharing
Soil is Variable

Rock

Contamination

Granular

Slope Instability

Weak Layers

Expansive

Fill

Cohesive

Groundwater

Anticipate and Prepare
Historical Data

Desktop Study
Safety

Electrical Clearances
Underground Facilities

Important for Utilities
Structures, Foundations, Loads

Early in the Process
A Few Common Systems
Different Load Magnitudes
Interrelated Systems

All Are Relevant to the Geotech
Tangent Structures

Often Directly Embedded

Typical Loads
Axial – 20k
Shear – 25k
Moment – 1500ft-k
Guyed Angle Structures

Medium or Two-Way Deadend
Bisector Guys
Guyed Each Direction
Embedded or Piers

Typical Loads
Axial – 140k
Shear – 3k
Moment – 200ft-k
Anchor tension – 40k
Self-supporting Structures

Medium Angle or Two-Way Deadend
Partial or No Guying

Typical Loads
Axial – 35k
Shear – 125k
Moment – 7000ft-k
Spread Footings

Primarily Vertical Loads
Transmission and Substation

Match Geotech Approach to Structures and Foundations
Soil Sampling and Testing

Match to Structures and Loads
Cohesive/Non-cohesive/Rock/Swamp, etc.
Consolidation - Settlement
Coordinate with Foundation Design Methodology

Geotechs Can Provide Value for these Decisions
Holes – Field Investigation

One per Soil Type
One per Mile for Transmission
One per Structure
Depth - Sampling - Testing
Cost-driven Soil Investigations

This Can Have $$$$ Implications

Geotechs Can Provide Value for this Decision
Design

Sample Rube Goldberg Machine
Capacity vs. Performance

**Capacity**
- Based on largest applied loads
- Designed to prevent failure

**Performance**
- Designed to perform well

Capacity ≠ Performance
Deflection vs. Rotation

- Pole top deflection limits
- Foundation deflection
- Foundation rotation

Which is More Critical?
Pole Top Deflection

- Sag
- Tension
- Clearances

Important Limitation
Pole Top Deflection Example

- 100 ft. pole
- 3 inch top of foundation deflection
- 1 degree top of foundation rotation

Pole Top Displacement (Deflection) = Foundation Deflection = 3 inches
Pole Top Displacement (Rotation) = 1.75 ft = 21 inches

Total pole tip displacement (deflection and rotation) = 3in + 21in = 24 in
## Foundation Design Options

<table>
<thead>
<tr>
<th>Drilled Pier Design Checks</th>
<th>Drilled Pier Design Programs</th>
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<tbody>
<tr>
<td><strong>Structural Capacity</strong></td>
<td>CAISSON</td>
</tr>
<tr>
<td>- Geotechnical Moment Capacity</td>
<td>YES</td>
</tr>
<tr>
<td>- Reinforced Concrete Moment Capacity</td>
<td>NO</td>
</tr>
<tr>
<td>- Reinforced Concrete Shear Capacity</td>
<td>NO</td>
</tr>
<tr>
<td>- Axial Capacity</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Performance Criteria</strong></td>
<td></td>
</tr>
<tr>
<td>- Total Tip Deflection</td>
<td>NO</td>
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<tr>
<td>- Total Tip Rotation</td>
<td>NO</td>
</tr>
<tr>
<td>- Non-Recoverable Tip Deflection</td>
<td>NO</td>
</tr>
<tr>
<td>- Non-Recoverable Tio Rotation</td>
<td>NO</td>
</tr>
</tbody>
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### Appropriate Soil Properties
Direct Embed Design Options

- Brom’s (cohesionless and cohesive)
  - Hansen’s Method
  - MFAD

Get Soil Tests to Match
Guy Anchors

Design Guidance by Manufacturers

Accurate Soil Classification
Spread Footings

More Common Foundation Design Methodologies

ACI Standards
General Design Comments

• Non/utility Soil Parameters
• Coordinate Safety Factors
• Total vs. Differential Settlement
  • Axial Capacity
  • Skin Friction

Get Soil Tests to Match
Construction
Contractor on Team

Biggest Friend or Toughest Foe
Construction Issues

- QA/QC
- Equipment Recommendations
  - Groundwater
- Surprise Soil Characteristics
  - Slope Instability
  - Bedrock

Geotechs Can Contribute Solutions!
C’mon Man!

Pole with the Wobbles
Upon Further Review

Throw the Flag!
Searching for Answers

Damage Assessment
Missing Pieces

This is Not Supposed to Happen
Geotechnical Engineers – Structural Engineers
A Valuable Partnership